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***Guarea guidonia* (L.) Sleumer**

**American muskwood**

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**Meliaceae Mahogany Family**

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American muskwood, *Guarea guidonia* (L.) Sleumer (28), also known simply as muskwood, is an evergreen tree with a spreading crown and dense foliage. Mature trees in Puerto Rico, often with fluted bases, have straight, clear trunks that reach a 25- to 30-m height and d.b.h.'s of up to 1 m. The even, pinnate leaves are large, 20 to 60 cm long, and alternately arranged, with 8 to 20 dark-green leaflets. The leaves continue to grow at the apex like a stem, and new leaflets are formed at the tip as other leaflets mature. The bark is rough, with many longitudinal fissures, and brown, with a distinct reddish tinge. Twigs are stout with many raised lenticels.

**HABITAT**

**Native Range**

American muskwood occurs from 22° N. to slightly beyond 25° S. latitude in the neotropics (27). It is reported as native in Cuba (41), Hispaniola (29), Puerto Rico, St. Croix, and Trinidad (33, 34, 3), and from Nicaragua (43, 44), Costa Rica (21), Panama, and Colombia (15), south to Brazil (20) and Argentina (14, 23) (fig. 1). It has been introduced into Florida, but is absent from the Lesser Antilles (4).

At the time of Puerto Rico's discovery, muskwood was a common component of the forests of the coastal plains and foothills, ranging up to 150 m in elevation (45). Today it is found throughout the lower mountain, moist limestone, and moist coastal regions of the Island. Moreover, it is one of the most common trees in Puerto Rican coffee plantations.

**Climate**

Muskwood grows in humid to wet subtropical and tropical regions. In the Caribbean islands, mean annual temperatures range from 21 to 25 °C and, in the continental areas, to about 30 °C. Throughout the natural range; with the exception of northern Argentina (14, 23), a frost-free climate prevails. In Argentina, maximum and minimum recorded temperatures were 41 and -5 °C, respectively. In the Caribbean islands, rainfall ranges from about 1100 to >3000 mm/yr. In continental areas such as Costa Rica (19) and Venezuela, rainfall may approach 4000 mm/yr,

with mean annual temperatures between 22 and 26 °C (17).

**Soils and Topography**

Muskwood was reported in Cuba on well-watered flatlands, in cool wet mountain valleys on alluvial soils, on humid slopes where the elevation ranged from 150 to 600 m, and on moist, upland limestone soils (41). In Puerto Rico's Luquillo Mountains, muskwood is most common on lower slopes, moist bottomlands, and river banks between elevations of 180 and 300 m (12). The species was also reported in riparian sites at 500-m elevations in Venezuela (36). Muskwood in Suriname was reported on ridges in rain forests and occasionally in savanna forests (26). In Trinidad, where detailed observations on tree distributions were made (3, table 1), muskwood was recorded in four associations and several different faciations (subdivisions



**Figure 1—Range of *Guarea guidonia* (American muskwood) in the New World.**

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**Table 1.**—Associated forest cover of and major trees species found with *Guarea guidonia*

Country	Locality	Elevation	Rainfall	Principal associated species <sup>1</sup>	Source
		<i>m</i>	<i>mm/yr</i>		
Argentina	Iguzu Park	30	2200	<i>Cocos romanzoffiana</i> , <i>Chrysophyllum lucumifolium</i> , <i>Balfourodendron riedelianum</i>	(14, 23)
Colombia	Canca Valley	1000	1000–2000	<i>Bursera simaruba</i> , <i>Spondias mombin</i> , <i>Chlorophora tinctoria</i>	(15)
Costa Rica	Puerto Viejo	130	4000	<i>Apeiba membranaceae</i> , <i>Brosimum lacteoesens</i> , <i>Carapa guianensis</i>	(19)
Cuba	Pico Turquino	150–750	~1500	<i>Andira jamaicensis</i> , <i>Cordia alliodora</i> <i>Bucida buceras</i> , <i>Calophyllum antillanum</i>	(40)
	Several	150–900	>1500	Deep valleys; <i>Andira inermis</i> , <i>Mastichodendron foetidissimum</i> , <i>Tabebuia</i> sp.	(41)
				Slopes: <i>Andira inermis</i> , <i>Mastidiodendron foetidissimum</i> , <i>Cedrela mexicana</i> , <i>Prunus mytifolia</i> , <i>Sapium jamaicense</i>	(41)
	Oriente	150–750	~1500	Monte fresco: <i>Buchenavia capitata</i> , <i>Calophyllum brasiliensis</i> , <i>Carapa guianensis</i> , <i>Sapium jamaicense</i> , <i>Prunus mytifolia</i>	(41)
	Sierra de Nipe	0–1000	1000–1500	<i>Nectandra coriacea</i> , <i>Tabebuia pacyphylla</i> , <i>Cedrela odorata</i>	(8)
Nicaragua	Lowland rain forest	0–1000	1500–2500	<i>Brosimum terrabanatum</i> , <i>Calophyllum brasiliense</i> , <i>Cedrela odorata</i> , <i>Swietenia macrophylla</i> <i>Tabebuia guayacan</i>	(43)
Puerto Rico	Islandwide	50–300	>1500	Coffee shade: <i>Inga</i> spp, <i>Andira inermis</i> + secondary regeneration	(5)
	Luquillo	100–300	3500	<i>Dacryodes excelsa</i> , <i>Manilkara bidentata</i> , <i>Sloanea berteriana</i>	(46)
Trinidad	Evergreen seasonal forest	0–250	1800–3000	<i>Carapa guianensis</i> — <i>Eschweilera subglandulosa</i> association: ranked from 14th to 45th in stem density in 3 faciations, mainly in canopy layer.	(3)
	Semi-evergreen seasonal forest	Lower slopes	<1500	<i>Peltogyne porphyrocardia</i> association ranked from 6th to 38th in stem density in 4 faciations in upper story	(3)
	Deciduous seasonal forest	Mountainous	1100–1500	<i>Bursera simaruba</i> — <i>Lonchocarpus punctatus</i> association: ranked 8th and 46th in stem density in 2 faciations as an emergent tree	(3)

**Table 1.**—Associated forest cover of and major trees species found with *Guarea guidonia*—continued

Country	Locality	Elevation	Rainfall	Principal associated species <sup>1</sup>	Source
		m	mm/yr		
	Seasonal montane forest	>500	High, mist	<i>Inga macrophylla</i> — <i>Guarea guara</i> association: ranked 9th in stem density as upperstory tree on mountainous slopes and ridges on limestone	(3)
Venezuela	Tropical moist forest	0–1000	1900–3700	<i>Parkia pendula</i> , <i>Calophyllum brasiliense</i> , <i>Pentaclethra macroloba</i> , <i>Swartzia</i> sp.	(17)
	Tropical dry forest	400–1000	1000–1800	<i>Cedrela mexicana</i> , <i>Tabebuia pentaphylla</i> , <i>Calicophyllum candidissimum</i> , <i>Chlorophora tinctoria</i>	(17)

<sup>1</sup>Only a few associated species have been listed for each site. Most species' lists from the cited references are extensive.

of ecological associations, characterized by codominants of two or more, but not all, of the dominant forms of the association, and that cover an area of considerable extent). In the seasonal montane forest, it was recorded on the limestone soils of misty mountainous slopes and ridges. In Puerto Rico's humid and wet secondary forests, muskwood is the second most common species and is noted for its use as coffee shade on the deep, clay soils of the central mountains (5).

Muskwood seedlings planted in open, degraded areas of Puerto Rico became chlorotic and stunted (31). On better sites, growth was satisfactory, especially under a shelterwood. In the eastern and central mountains, muskwood plantings were reported as promising on lower concave slopes, valleys, and straight slopes. In the limestone region, only sites classified as lower slopes, valleys, and sinkholes gave promising results. On serpentine areas, muskwood was promising in narrow river valleys and concave slopes. Soils on these lower slopes and valleys are generally deeper, more moist, and more fertile than soils on upper slopes and ridgetops.

#### Associated Forest Cover

Muskwood grows naturally in humid subtropical and tropical forests and on moist sites in tropical dry forests (table 1). In Puerto Rico, it is most common in the subtropical moist forest and subtropical wet forest life zones (5, 18), similar to its habitats in Cuba where life zones have not yet been mapped. It was reported in Venezuela's tropical dry and moist forests (17), in Costa Rica's tropical wet forest (19), and in Nicaragua's lowland rain forest (43). In Colombia, muskwood was found in the tropical dry forest in the Cauca Valley (15).

The major forest types, a few associated tree species, and site information from forest surveys where muskwood has been recorded are shown in table 1. Muskwood is

generally an uncommon component of undisturbed natural humid lowland and lower mountain forests throughout the region. For example, at lower elevations in the Luquillo Mountains of Puerto Rico, it ranked 24th in stem density, 21st in basal area dominance, and 20th in volume for all trees sampled on 4 ha of permanent plots (6, 46). The exception is on Trinidad, where it was recorded as a common component of certain faciations (3, table 1).

#### LIFE HISTORY

##### Reproduction and Early Growth

**Flowering and Fruiting.**—In Puerto Rico, flower production occurs in April and May, and again from October to December (16). The greenish white flowers consist of a four-lobed calyx and four hairy petals. The nearly round reddish-brown seed capsules, about 1.6 cm across, are borne in panicles. Each produces four or fewer seeds. An average of three seeds per capsule was found in Puerto Rico. In tropical wet forests of Costa Rica, no significant period of leaf fall was observed, and leaf flushing was discontinuous (19). Flowering was mainly in January and February, with mature fruit being produced in February and March.

**Seed Production and Dissemination.**—Two experiments to determine the wet weight of seeds collected in Puerto Rico showed 2,170 and 2,990 seeds per kg. When seeds from two 50-gram samples were cut open, 92 percent of the seeds were fertile. The determination of moisture content based on two 70-gram samples gave an average of 37 percent. The seeds are perishable. If stored without sealing at either room temperature or 4 °C, they lose viability after 1 month.

In Puerto Rico, fruits are dropped at the time of flowering (16). In Trinidad, natural regeneration is not

plentiful, partially because seed is eaten by mammals and birds (34). The fruit, however, has been reported as being poisonous to animals (1).

**Seedling Development.**—Germination is hypogeous, and early leaves are simple (34). In Puerto Rico, two trials were used to assess germination. The first trial indicated an immediate 47-percent germination, but none thereafter. The seeds had been stored for five different periods, up to 9 months, in unsealed paper sacks at room temperature and at 4°C. It was concluded that the seeds lost their moisture rapidly and were perishable. In a second trial, 2 lots of 500 seeds each were sown shortly after collection in the field, 1 in the sun and the other in partial shade. After 63 days, 12 percent of those in the sun and 57 percent of those in the shade had germinated. After 113 days, the results were 28 and 65 percent, respectively.

In Trinidad, germination for seeds planted in the open varied from 8 to 75 percent depending on locale, usually commencing in 5 to 10 weeks and continuing for 3 to 6 months (34). Germination was 50 percent for seeds broadcast in the open and 60 percent for seeds dibbled under light shade. Seeds that had been broadcast under shade, however, showed virtually no germination.

In Puerto Rico, nearly 190,000 muskwood seedlings were planted in the Luquillo and Toro Negro forests by 1945 (31). In the remaining insular forests, 256,000 seedlings were planted by mid-1949 (32). Seedlings ranged from 30 to 60 cm in height and were bare-root planted at 1.8- by 1.8-m spacings. Survival was about 90 percent on favorable sites (31) and rated as fair for several less favorable sites (32). Wildlings up to 2.5 cm in diameter were also used, some after pruning the top. The use of large wildlings proved advantageous because they outgrew the weeds sooner than wildlings of smaller dimension.

Seedling growth was reported as slow in Trinidad, averaging 15 cm in height at 6 months and 2 m at 3 years (34). Early seedling growth was also evaluated in Puerto Rico. In the sun, 13 seedlings averaged 18 and 22 cm after 6 and 7 months, respectively. In the shade, comparable growth rates were 25 and 36 cm.

**Vegetative Reproduction.**—In Trinidad, muskwood is reported to coppice fairly well until reaching an advanced age (34).

### Sapling and Pole Stage to Maturity

**Growth and Yield.**—Growth data for several sites may be found in table 2. Seedlings and sapling growth ranged from 0.3 to 0.6 m/yr in height and from 0.2 to 0.6 cm/yr in diameter. In Puerto Rico's subtropical wet forest in the Luquillo Mountains, diameter growth averaged 0.81 cm/yr over an 18-year period, the highest mean for 17 species sampled (13). In Puerto Rico's humid secondary forests, diameter increment for muskwood averaged 0.57 cm/yr for all crown classes combined and 0.88 cm/yr for dominant stems alone (50). Again, muskwood diameter growth was the most rapid of the species sampled. Test plantations established by the USDA Forest Service, however, showed the species to be slower in growth than broadleaf mahogany (31), so the latter was substituted on sites where it was better adapted (27). Muskwood

apparently thrives best in forested conditions (31). Plantings on degraded sites in the open generally fail (31).

**Root Habit.**—No information could be found on the rooting habit of muskwood. Given the frequent occurrence of muskwood on lower slopes in humid lowlands where soils are usually deep and fertile might suggest a deep rooting habit.

**Reaction to Competition.**—Muskwood reaches the upper canopy on favorable sites, but is not a dominant tree in the forests of Puerto Rico (31) or Venezuela (17). In Trinidad, it was mainly recorded as an upper story species, but in some instances, it was emergent (3, table 1). In Costa Rica, it was also recorded as an upper story tree (19).

In a comparative study of the regeneration and understory survival of 29 species that reach canopy size in the subtropical wet forest of the Luquillo Mountains, understory trees of muskwood were relatively common whereas seedlings were relatively scarce (42). Such a population structure suggests that muskwood's regeneration may be related to a past disturbance of the forest. The population data along with information on seed size and tree specific gravity were used to classify muskwood as a climax forest species.

Muskwood underplanted in a palm forest at an elevation of about 900 m in the central mountains of Puerto Rico showed high survival and satisfactory growth after 5 years (table 2). The species was also reported as moderately shade tolerant in Trinidad (34). In summary, muskwood appears adapted to some shade as a seedling and understory tree. However, its regeneration in closed subtropical wet forests of the Luquillo Mountains is rare, suggesting that the light shade characteristic of small gaps in the canopy, possibly caused by hurricanes, may facilitate its germination and early growth.

Muskwood, either as a second-growth species or deliberately planted, is commonly used as overhead shade in Puerto Rico's coffee plantations (5). Given its value as a cabinetwood, thinnings were suggested as a means to improve its growth potential and that of other timber species found in abandoned coffee plantations (49).

**Damaging Agents.**—In Puerto Rican plantings of muskwood, seedlings were reported free of insect attack (31). A leaf spot was observed on some wildlings, but the disease was not considered as being detrimental. In Trinidad, seedling mortality was often high due in part to the seedlings being attacked by insects (34). In Venezuela, muskwood was not infested by the mahogany shoot borer (9). Moreover, the heartwood is resistant to dry-wood termites and is durable in the ground (53, 7, 10).

Muskwood has been susceptible to hurricanes in Puerto Rico. The San Felipe hurricane of 1928 caused defoliation, crown breakage, splitting of trunks, and uprooting of muskwood in several areas of the Island (2). The Santa Clara hurricane of 1956 caused breakage of muskwood in the Guajataca area (48). In the latter instance, a previously thinned stand ranging in d.b.h. from 15 to 25 cm suffered damage in more than 50 percent of the crowns, whereas a nearby unthinned stand showed only slight damage. Of the two storms, San Felipe was by far the more destructive.

**Table 2.**—Growth information for *Guarea guidonia*

Country	Locality	Elevation	Rainfall	Survival	Duration	Mean growth		Comments	Source
						Height	D.b.h.		
		<i>m</i>	<i>mm/yr</i>	<i>Percent</i>	<i>Years</i>	<i>m/yr</i>	<i>cm/yr</i>		
Dominican Republic	Las Montañas Arriba	700	1150	62	0.8	0.35	... <sup>1</sup>	Degraded soil	(22)
Puerto Rico	Luquillo	100–900	2500–3800	50–100	6	0.61	0.64	Slope topography	(31)
	Toro Negro	900	2500	High	4	0.46	0.32	Valley topography	(31)
	Toro Negro	900	2500	High	6	0.3–0.6	0.2–0.5	Shelterwood under palm forest	(31)
	Guilarte	900	2300	... <sup>1</sup>	5	0.58	0.07	Volcanic soils, clays; slopes	(32)
	Sabana 8	180–360	2300	...	19	...	0.81	Natural forest, range of d.b.h. growth, 0.13–1.35 cm/yr; 18 trees	(13)
	Secondary forest	150–900	1500–2500	...	5	...	0.57	For 155 trees in moist and wet secondary forest—D.b.h. increment in cm/yr by crown class: 0.88 for dominants, 0.73 for codominants, 0.37 for intermediates, and 0.18 for small trees not classified.	(50)
	Secondary forest	300–550	2000	...	27	...	0.60	For 16 trees in moist secondary forests; shallow to moderately deep, well-drained clay loams	(39)
	Secondary forest	40	1900	...	32	...	0.37	Secondary woodlot with mixed species' composition	(51)

<sup>1</sup>Information not given in columns or rows is not available.

## SPECIAL USES

In the West Indies, muskwood, which resembles mahogany and Spanish-cedar, was employed for the same purposes as those species, but the supply was never abundant (37). In Puerto Rico, it was an important source of timber prized for the construction of strong wagons and farm implements (38) and is considered the best native furniture wood of the tabonuco forest (47). Muskwood is of medium weight with a specific gravity of 0.51 g/cm<sup>3</sup>. The wood is strong and tough in comparison to other woods of similar density (30). The wood saws and machines easily and takes a high lustrous finish with either varnish or lacquer. Neither the heartwood nor the sapwood is responsive to preservation treatments using open-tank or pressure-vacuum systems.

The attractiveness, good strength, durability, and favorable working properties of muskwood (24, 25) make it well suited for many uses: furniture and cabinet work,

turnery, interior trim, general construction, and carpentry (30, 27), as well as ship construction, including planking, trim, utility veneer, and plywood (10). For veneer, the wood may be similar to related species, but it requires considerable steaming for either rotary or slicing operations.

In Puerto Rico, muskwood was recommended as an ornamental shade tree (52, 35) and is currently one of the most common shade trees in coffee plantations (5). In Argentina, the bark was used for tanning (38). Moreover, the powdered bark has been used as an emetic and a hemostatic (37), and the leaves and roots have been used for home medicines (27, 11).

## GENETICS

No genetics work has been reported in the literature. Muskwood was first referred to as *G. guara* (Jacq.) P.



Wils., and later as *G. trichiloides* L., before its current designation as *G. guidonia* (L.) Sleumer. Given its wide range and apparent adaptation to tropical, subtropical, and very mild temperate conditions, some variation in the species may be expected.

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